Learning Module Outline

Short Description	
Description of the module	**Case Studies from Aerospace Applications** This module focuses on the principles and practical applications of 3D printing design and manufacturing in the aerospace industry. It begins with an introduction to conventional digital design methodologies and then explains how these methods are adapted to address the unique opportunities and constraints associated with additive manufacturing technologies. Particular emphasis is placed on the concept of Design for Additive Manufacturing (DFAM), which is presented through its methodological framework and the fundamental stages of the design process: design requirements, conceptual design, embodiment design, detail design, and manufacturing. Each of these stages is discussed in detail to demonstrate how engineers can develop components that fully exploit the advantages of additive manufacturing, including weight reduction, part consolidation, geometric complexity, and functional integration. Throughout the module, the discussion is closely linked to aerospace applications, where stringent requirements for structural efficiency, reliability, and material performance make additive manufacturing an increasingly important manufacturing approach. In addition to the theoretical foundations, the module incorporates practical case studies involving both polymeric and metallic materials used in aerospace applications. The polymer-based case study examines the design and fabrication of lightweight structural components for unmanned aerial vehicles (UAVs), highlighting considerations such as topology optimization, material selection, and fabrication using material extrusion technologies. The metallic case study focuses on the additive manufacturing of aero-engine components, emphasizing issues related to powder-based processes, thermal effects, post-processing, and quality assurance. For each case study, appropriate additive manufacturing methods are selected and justified according to material characteristics, functional requirements, and production constraints. The module also presents a step-by-step algorithm that outlines the complete workflow, beginning with design specification and concept development and continuing through simulation, manufacturing, post-processing, and inspection. By combining theoretical principles with real-world aerospace examples, this module provides a comprehensive understanding of how additive manufacturing can be effectively implemented in advanced aerospace engineering applications. The overall content and organization of the module are outlined below. 1. Introduction 2. Digital Product Design 3. Capabilities of 3D Printing in Digital Design and Manufacturing 4. Fundamental Steps in DFAM 5. Case Studies for Aerospace Components 5.1. 3D Printing of a Polymeric Material 5.2. 3D Printing of a Metallic Material 6. Conclusions

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Target Groups	
Targets	• Engineering students (Aerospace, Aeronautical, Materials and Mechanical Engineering) • Engineers and technical staff in aerospace and aeronautical industries

Learning Objectives	
Learning Objectives for this module	Upon completion of this module, participants will be able to: • Identify process requirements specific to aerospace materials. • Select appropriate process parameters for 3D printing operations. • Design and sequence process steps involved in 3D printing workflows. • Understand and apply digital tools used in 3D printing processes.

Learning Resources	
Resources	• Scientific articles • Industrial reports • Books • Thesis • Tutorials • Application videos

Self-assessment and Learning Activities	
Self-assessment and Learning Activities	• Textbook • Lesson presentations • Lesson reviews • Quizzes

This document was prepared by the project teams from TEI and Eskişehir Osmangazi University.

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